IN THE CLAIMS:

1. (Previously Presented) A method for determining faults on operation of a pump assembly, the method comprising the steps of:

providing the pump assembly with a pump motor with at least two electrical variables of the motor determining the electrical power of the motor, and the pump having at least one changing hydraulic variable of the pump;

providing an electrical detection means for detecting the electrical variables of the motor;

providing a hydraulic detection means for detecting the changing hydraulic variable of the pump;

detecting the electrical variables of the motor with the electrical detection means;

detecting the hydraulic variable of the pump with the hydraulic detection means;

providing a mathematical electrical motor model for generating a motor value from a mathematical linking of the detected electrical variables of the motor;

generating the motor value by input of the detected electrical variables of the motor into the mathematical electrical motor model;

providing a mathematical mechanical-hydraulic pump model for generating a pump comparison value from a mathematical linking of the motor value and the detected hydraulic variable of the pump;

generating the pump comparison value by input of the motor value and the detected hydraulic variable of the pump into the mathematical mechanical-hydraulic pump model;

providing a predefined pump value;

comparing the pump comparison value to the predefined pump value to detect agreement or a difference between the pump comparison value and the predefined pump value; and

generating an error signal upon detecting a difference between the pump comparison value and the predefined pump value beyond a certain measure to indicate a faulty function of the pump.

2. (Previously Presented) A method according to the introductory part of claim 1, wherein the two electrical variables of the motor which determine the electrical power of the motor, are the voltage prevailing at the motor and the current feeding the motor.

3. (Currently Amended) A method according to claim 1, wherein ~~when the presence of a fault is determined, one then further determines as to which fault it is a case of~~ after generating the error signal, determining what faulty function of the pump caused the generating of the error signal.

4. (Previously Presented) A method according to claim 1, wherein the detected hydraulic variable is the pressure produced by the pump.

5. (Previously Presented) A method according to claim 1, wherein the detected hydraulic variable is the delivery quantity of the pump.

6. (Previously Presented) A method according to claim 1, wherein the detected hydraulic variable is the differential pressure between the suction side and the pressure side of the pump.

7. (Canceled)

8. (Previously Presented) A method according to claim 1, wherein the electrical motor model is formed by the following equations

$$L'_s \frac{di_{sd}}{dt} = -R'_s i_{sd} + \frac{L_m}{L_r}\left(R'_r \psi_{rd} + z_p \omega \psi_{rq}\right) + v_{sd} \quad (1)$$

$$L'_s \frac{di_{sq}}{dt} = -R'_s i_{sq} + \frac{L_m}{L_r}\left(R'_r \psi_{rq} - z_p \omega \psi_{rd}\right) + v_{sq} \quad (2)$$

$$\frac{d\psi_{rd}}{dt} = -R'_r \psi_{rd} - z_p \omega \psi_{rq} + R'_r L_m i_{sd} \quad (3)$$

$$\frac{d\psi_{rq}}{dt} = -R'_r \psi_{rq} + z_p \omega \psi_{rd} + R'_r L_m i_{sq} \quad (4)$$

$$T_e = z_p \frac{3}{2} \frac{L_m}{L_r}\left(\psi_{rd} i_{sq} - \psi_{rq} i_{sd}\right) \quad (5)$$

or

$$V_s = Z_s(s) I_s \quad (6)$$

$$\omega = \omega_s - s\omega_s \quad (7)$$

$$I_r = \frac{V_s}{Z_r(s)} \quad (8)$$

$$T_e = \frac{3R_r I_r^2}{s} \quad (9)$$

or

$$L_s \frac{di_{sd}}{dt} = -R_s i_{sd} + z_p \omega L_s \psi_{rq} + v_{sd} \quad (10)$$

$$L_s \frac{di_{sq}}{dt} = -R_s i_{sq} - z_p \omega L_s \psi_{rd} + v_{sq} \qquad (11)$$

$$\frac{d\psi_{rd}}{dt} = -z_p \omega \psi_{rq} \qquad (12)$$

$$\frac{d\psi_{rq}}{dt} = z_p \omega \psi_{rd} \qquad (13)$$

$$T_e = z_p \frac{3}{2}\left(\psi_{rd} i_{sq} - \psi_{rq} i_{sd}\right) \qquad (14)$$

in which

i_{sd} is the motor current in direction d

i_{sq} the motor current in direction q

Ψ_{rd} the magnetic flux of the rotor in the d-direction

Ψ_{rq} the magnetic flux of the rotor in the q-direction

T_e the motor moment

v_{sd} the supply voltage of the motor in the d-direction

v_{sq} the supply voltage of the motor in the q-direction

ω the angular speed of the rotor and impeller or the actual rotor and impeller rotational speed

R'_s the equivalent resistance of the stator winding of a asynchronous motor

R'_r the equivalent resistance of the rotor winding of the asynchronous motor

L_m the inductive coupling resistance between the stator and the rotor winding

L'_s the inductive equivalent resistance of the stator winding

L_r the inductive equivalent resistance of the rotor winding

z_p the pole pair number

I_s the phase current

V_s the phase voltage

ω_s the frequency of the supply voltage

$Z_s(s)$ the stator impedance

$Z_r(s)$ the rotor impedance

R_r the equivalent resistance of the rotor winding of a permanent magnet motor

R_s the equivalent resistance of the stator winding of the permanent magnet motor

L_s the inductive resistance of the stator winding

wherein d and q are two directions perpendicular to the motor shaft and perpendicular to one another and wherein the mechanical-hydraulic pump/motor model is formed by the equation

$$J \frac{d\omega}{dt} = T_e - B\omega - T_P \qquad (15)$$

and at least one of the equations

$$H_p = -a_{h2}Q^2 + a_{h1}Q\omega + a_{h0}\omega^2 \qquad (16)$$

$$T_p = -a_{t2}Q^2 + a_{t1}Q\omega + a_{t0}\omega^2 \qquad (17)$$

in which is/are

$\frac{d\omega}{dt}$ the temporal derivative of the angular speed of the rotor,

T_p the pump torque,

J the moment of inertia of the rotor, impeller and the delivery fluid contained in the impeller,

B the friction constant,

Q the delivery flow of the pump,

H_p the differential pressure produced by the pump,

a_{h2}, a_{h1}, a_{h0} the parameters which describe the relationship between the rotational speed of the impeller, the delivery flow and the differential pressure and

a_{t2}, a_{t1}, a_{t0} the parameters which describe the relation between the rotational speed of the impeller, the delivery flow and the moment of inertia.

9. (Previously Presented) A method according to claim 8, wherein the variables a_{h0}- a_{h2} and a_{t0} - a_{t2} are predefined in the equations (16) and (17) as well the variables B and J in the equation (15), wherein a motor moment (T_e) is determined from the electrical motor model according to the equations (1) - (5) or (6) - (9) or (10) - (14), and the rotational speed is either computed according to the equations (1) - (5) or (6) - (9) or (10) - (14) or measured, whereupon with the help of the equations (16) and/or (17), one determines a relationship between pressure and delivery quantity on the one hand and/or between power/moment and delivery quantity on the other hand, whereupon preferably one checks with equation (15) as to whether the variables computed with the help of the motor model agree or not with those variables computed with the help of the pump model after the substitution of the measured hydraulic variables, wherein a fault is registered should there be no

agreement.

10. (Original) A method according to claim 8, wherein a tolerance band is fixed by way of variance of at least one of the variables a_{ho}- a_{h2} and a_{t0} - a_{t2} and B and J.

11. (Previously Presented) A method according to claim 8, wherein for determining the type of fault, additionally to the two electrical variables, two hydraulic variables are determined, by way of measurement, and the determined values are substituted into the equations, in a manner such that several fault variables (r_1 - r_4) result, wherein the type of fault is determined by way of the combination of fault variables and by way of predefined boundary value combinations.

12. (Currently Amended) A method according to claim 1,wherein for determining ~~the~~ a type of faulty function of the pump that caused the generating of the error signal, additionally to the two electrical variables, two hydraulic variables are determined, ~~preferably~~ by way of measurement, and the determined values or values derived therefrom are compared to predefined values, wherein the predefined values in each case define a surface, wherein one determines whether the determined variables or those derived therefrom lie on one of these surfaces (r^*_1- r^*_4) or not, and the type of fault is determined by way of the combination of the fault variables and by way of predefined boundary value combinations.

13. (Previously Presented) A method according to claim 1, wherein the evaluation of the fault type is effected by way of the following table:

fault type / fault variable / comparative surface	r_1, r_1^*	r_2, r_2^*	r_3, r_3^*	r_4, r_4^*
increased friction on account of mechanical defects	1	0	1	1
reduced delivery/ absent pressure	0	1	1	1
defect in suction region/ absent delivery quantity	1	1	0	1
delivery stoppage	1	1	1	1

14. (Previously Presented) A method according to claim 1, wherein on determining a fault, the pump assembly is activated with a changed rotational speed, in order by way of the measurement results which then set in, to more accurately specify the determined fault.

15. (Previously Presented) A method according to claim 1, wherein the mechanical-hydraulic pump/motor model also includes at least parts of the hydraulic system affected by the

pump, in a manner such that faults of the hydraulic system may also be determined.

16. (Previously Presented) A method according to claim 15, wherein the hydraulic system is defined by the equation

$$K_J \frac{dQ}{dt} = H_p - (p_{out} + \rho g z_{out} - p_{in} - \rho g z_{in}) - (K_v + K_l)Q^2 \qquad \textbf{(18)}$$

in which is/are

K_J the constant which describes the mass inertia of the fluid column in the pipe system,

K_V the constant which describes the flow-dependent pressure losses in the valve, and

K_L the constant which describes the flow-dependent pressure losses in the pipe system,

Q the delivery flow of the pump

H_p the differential pressure of the pump

P_{out} the pressure at the consumer-side end of the installation,

P_{in} the supply pressure

Z_{out} the static pressure level at the consumer-side end of the installation,

Z_{in} the static pressure level at the pump entry,

p the density of the delivery medium

g the gravitational constant.

17. (Previously Presented) A method according to claim 11, wherein the variables r_1 - r_4 are defined by the equations

$$\begin{cases} J\frac{d\hat{\omega}_1}{dt} = -B\hat{\omega}_1 - \left(-a_{t2}Q^2 + a_{t1}Q\omega + a_{t0}\omega^2\right) + T_e + k_e(\omega - \hat{\omega}_1) \\ r_1 = q_1(\omega - \hat{\omega}_1) \end{cases} \tag{19}$$

$$\left\{ r_2 = q_2\left(-a_{h2}Q^2 + a_{h1}\omega Q + a_{h0}\omega^2 - H_p\right) \right. \tag{20}$$

$$\begin{cases} Q' = \frac{a_{h1}\omega + \sqrt{a_{h1}^2\omega^2 - 4a_{h2}(H_p + a_{h0}\omega^2)}}{2a_{h2}} \\ J\frac{d\hat{\omega}_3}{dt} = -B\hat{\omega}_3 - \left(-a_{t2}Q'^2 + a_{t1}Q'\omega + a_{t0}\omega^2\right) + T_e + k_3(\omega - \hat{\omega}_3) \\ r_3 = q_3(\omega - \hat{\omega}_3) \end{cases} \tag{21}$$

$$\begin{cases} \omega' = \frac{-a_{h1}H_p + \sqrt{a_{h1}^2 H_p{}^2 - 4a_{h2}(H_p + a_{h0}Q^2)}}{2a_{h2}} \\ J\frac{d\hat{\omega}_4}{dt} = -B\hat{\omega}_4 - \left(-a_{t2}Q^2 + a_{t1}Q\omega' + a_{t0}\omega'^2\right) + T_e + k_4(\omega' - \hat{\omega}_4) \\ r_4 = q_4(\omega' - \hat{\omega}_4) \end{cases} \tag{22}$$

in which represent(s)

k_1, k_3, k_4, constants,

q_1, q_2, q_3, q_4 constants,

Q' the computed delivery quantity on the basis of current rotational speed and measured pressure,

$\hat{\omega}_1$ the computed rotor rotational speed on the basis of the mechanical-hydraulic equations (15) and (17),

$\hat{\omega}_3$ the computed rotor rotational speed on the basis of the equations (15), (16) and (17).

$\hat{\omega}_4$ the computed rotor rotational speed on the basis of the equations (15), (16) and (17),

ω' the computed rotor rotational speed on the basis of the measured delivery pressure and measured delivery quantity

r_1-r_4 fault variables, and

r_1*- r_4* surfaces determined by three variables, which represent a fault-free operation of the pump.

18. (Previously Presented) A device for determining faults with operating conditions of a centrifugal pump assembly, the device comprising:

a pump motor with at least two electrical variables of the motor determining the electrical

power of the motor, the pump assembly having at least one changing hydraulic variable;

an electrical detection means for detecting the two electrical variables which determine the power of the;

hydraulic detection means for detecting the changing hydraulic variable of the pump; and

an evaluation means which determines a fault condition of the pump assembly by way of the detected variables, the evaluating means

providing a mathematical electrical motor model for generating a motor value from a mathematical linking of the detected electrical variables of the motor;

generating the motor value by input of the detected electrical variables of the motor into the mathematical electrical motor model;

providing a mathematical mechanical-hydraulic pump model for generating a pump comparison value from a mathematical linking of the motor value and the detected hydraulic variable of the pump;

generating the pump comparison value by input of the motor value and the detected hydraulic variable of the pump into the mathematical mechanical-hydraulic pump model;

providing a predefined pump value;

comparing the pump comparison value to the predefined pump value to detect agreement or a difference between the pump comparison value and the predefined pump value; and

generating an error signal upon detecting a difference between the pump comparison value and the predefined pump value beyond a certain measure to indicate a faulty function of the pump.

19. (Canceled)

20. (Canceled)

21. (Previously Presented) A device according to claim 18, wherein the device is an integral component of ~~the~~ motor electronics and/or pump electronics of the pump.

22. (Previously Presented) A device according to claim 18, wherein means are provided to produce and transmit at least one fault notification.

23 (Previously Presented) A method for determining faults on operation of a pump assembly, the method comprising the steps of:

acquiring at least two electrical variables of a motor of the pump assembly, which electrical variables determine the electrical power of the motor, and acquiring at least one changing hydraulic variable of the pump, and acquiring at least one further mechanical or hydraulic variable which determines the power of the pump;

mathematically linking the two electrical variables of the motor which determine the electrical power of the motor for providing at least one comparison value;

mathematically linking the at least one changing hydraulic variable of the pump, as well as the at least one further mechanical or hydraulic variable determining the power of the pump for

providing at least one pump comparison value, wherein a mathematical electrical motor model is used in combination with a mathematical mechanical-hydraulic pump model / motor model for the mathematical linking steps;

comparing the results of the mathematical linking steps with at least one predefined value; and

generating an error signal upon detecting a difference between the results of the mathematical linking steps and the at least one predefined value, which difference is beyond a certain measure, to indicate a faulty function of the pump.

24. (Previously Presented) A method according to claim 1, wherein a voltage prevailing at the motor and a current feeding the motor are acquired as the electrical variables determining the electrical power of the motor and the acquired hydraulic variable is the pressure produced by the pump.

25. (Previously Presented) A method according to claim 23, wherein the electrical motor model is formed by the following equations

$$L'_s \frac{di_{sd}}{dt} = -R'_s i_{sd} + \frac{L_m}{L_r}\left(R'_r \psi_{rd} + z_p \omega \psi_{rq}\right) + v_{sd} \tag{1}$$

$$L'_s \frac{di_{sq}}{dt} = -R'_s i_{sq} + \frac{L_m}{L_r}\left(R'_r \psi_{rq} - z_p \omega \psi_{rd}\right) + v_{sq} \tag{2}$$

$$\frac{d\psi_{rd}}{dt} = -R'_r \psi_{rd} - z_p \omega \psi_{rq} + R'_r L_m i_{sd} \tag{3}$$

$$\frac{d\psi_{rq}}{dt} = -R'_r \psi_{rq} + z_p \omega \psi_{rd} + R'_r L_m i_{sq} \tag{4}$$

$$T_e = z_p \frac{3}{2} \frac{L_m}{L_r}\left(\psi_{rd} i_{sq} - \psi_{rq} i_{sd}\right) \tag{5}$$

or

$$V_s = Z_s(s) I_s \tag{6}$$

$$\omega = \omega_s - s\omega_s \tag{7}$$

$$I_r = \frac{V_s}{Z_r(s)} \tag{8}$$

$$T_e = \frac{3R_r I_r^2}{s} \tag{9}$$

or

$$L_s \frac{di_{sd}}{dt} = -R_s i_{sd} + z_p \omega L_s \psi_{rq} + v_{sd} \tag{10}$$

$$L_s \frac{di_{sq}}{dt} = -R_s i_{sq} - z_p \omega L_s \psi_{rd} + v_{sq} \tag{11}$$

$$\frac{d\psi_{rd}}{dt} = -z_p \omega \psi_{rq} \tag{12}$$

$$\frac{d\psi_{rq}}{dt} = z_p \omega \psi_{rd} \tag{13}$$

$$T_e = z_p \frac{3}{2}\left(\psi_{rd} i_{sq} - \psi_{rq} i_{sd}\right) \tag{14}$$

in which

i_{sd} is the motor current in direction d

i_{sq} the motor current in direction q

Ψ_{rd} the magnetic flux of the rotor in the d-direction

Ψ_{rq} the magnetic flux of the rotor in the q-direction

T_e the motor moment

v_{sd} the supply voltage of the motor in the d-direction

v_{sq} the supply voltage of the motor in the q-direction

ω the angular speed of the rotor and impeller or the actual rotor and impeller rotational speed

R'_s the equivalent resistance of the stator winding of a asynchronous motor

R'_r the equivalent resistance of the rotor winding of the asynchronous motor

L_m the inductive coupling resistance between the stator and the rotor winding

L'_s the inductive equivalent resistance of the stator winding

L_r the inductive equivalent resistance of the rotor winding

z_p the pole pair number

I_s the phase current

V_s the phase voltage

ω_s the frequency of the supply voltage

$Z_s(s)$ the stator impedance

$Z_r(s)$ the rotor impedance

R_r the equivalent resistance of the rotor winding of a permanent magnet motor

R_s the equivalent resistance of the stator winding of the permanent magnet motor

L_s the inductive resistance of the stator winding

wherein d and q are two directions perpendicular to the motor shaft and perpendicular to one another and wherein the mechanical-hydraulic pump/motor model is formed by the equation

$$J \frac{d\omega}{dt} = T_e - B\omega - T_P \tag{15}$$

and at least one of the equations

$$H_p = -a_{h2}Q^2 + a_{h1}Q\omega + a_{h0}\omega^2 \tag{16}$$

$$T_p = -a_{t2}Q^2 + a_{t1}Q\omega + a_{t0}\omega^2 \tag{17}$$

in which is/are

$\frac{d\omega}{dt}$ the temporal derivative of the angular speed of the rotor,

T_p the pump torque,

J the moment of inertia of the rotor, impeller and the delivery fluid contained in the impeller,

B the friction constant,

Q the delivery flow of the pump,

H_p the differential pressure produced by the pump,

a_{h2}, a_{h1}, a_{h0} the parameters which describe the relationship between the rotational speed of the impeller, the delivery flow and the differential pressure and

a_{t2}, a_{t1}, a_{t0} the parameters which describe the relation between the rotational speed of the impeller, the delivery flow and the moment of inertia.